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DEPARTMENT OF TRANSPORTATION
ADMINISTRATION
DIVISION OF PROCUREMENT AND CONTRACTS
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SPECIFICATION FOR GLASS SPHERES (BEADS)

1.0 SCOPE

This specification covers glass spheres (beads) for use in providing nighttime retro-reflectance in painted traffic lines and other markings used in highway delineation.

- 1.1** Type I beads are not coated. Type II beads have a moisture-proof coating that promotes the free flow of beads in high humidity conditions.

2.0 SPECIFICATIONS AND STANDARDS

- 2.1** Specifications and standards referenced in this document in effect on the opening of the Invitation for Bid form a part of this specification where referenced.

3.0 REQUIREMENTS

- 3.1** Glass spheres, Type I and Type II, shall meet the following requirements.

- 3.1.1 General:** Glass spheres shall lend themselves readily to firm embedment in traffic paint when dropped on a freshly placed paint line. The embedment shall be of such nature so as to provide a highly retroreflective surface on the paint with reserve retroreflective capacity in the lower sections of the paint film. This retroreflection shall be evident to the operator of a motor vehicle at night when the headlights of the vehicle are directed at the marking.

- 3.1.2 Appearance:** A minimum of 85% of the beads by count shall be colorless, true spheres, free of dark spots, milkiness, air inclusions and surface scratches when viewed under 20X magnification. The beads shall be clean and free from foreign matter in accordance with high grade commercial practice.

Note: This specification cancels and supercedes; specification #8010-004 (October, 1998), specification #8010-21C-22 (March, 1992) and specification #8010-11E-22 (May, 1991).

3.1.3 Gradation: The glass spheres shall conform to the following gradation requirements:

Sieve Opening	U.S. Std. Sieve #	% By Weight Passing
600 μm	#30	100
250 μm	#60	40 - 70
180 μm	#80	15 - 35
106 μm	#140	0 - 5

3.1.4 Refractive Index: The beads shall have a minimum refractive index of 1.5 when tested by the oil immersion method using a tungsten light (see ASTM Special Publication 500 Paragraph 1.3.2.1).

3.1.5 Specific Gravity: The beads shall have a specific gravity between 2.40 and 2.60 at 25°C, when tested per ASTM D-153, Method A.

3.1.6 Moisture Content: Determine the moisture content by weighing a 25 g sample of the beads and placing the sample in a 105°C oven for 3 hrs. After 3 hrs, cool the sample in a dessicator, then re-weigh and calculate the % moisture content (% weight loss). The moisture content shall not exceed 0.01%.

3.1.7 Chemical Stability: Refluxing of a 50 g sample of beads in a Soxhlet extraction apparatus for 8 hours with distilled water shall not produce more than a very slight reduction in luster or reflecting power of the beads.

3.1.8 Flow: Beads shall be free flowing. A 23 kg sample of beads, when emptied into a service box screen having sieve openings of 1.18 mm (U.S. Standard Sieve #16), shall pass completely through the screen without shaking or any excessive hand manipulation.

3.1.9 Bulk Color: Use a riffle splitter to obtain a 160-gram (plus or minus 10-gram) sub-sample of the glass bead sample. Place this sub-sample of beads in a round-bottom, porcelain, evaporating dish (Coors #60200, 120 ml capacity). Tap the dish gently to level the beads in the dish. Place this dish in a cold muffle furnace and heat the bead sample to 800°C. Allow the sample to remain at this temperature for 2 to 3 hours. Shut-off the muffle furnace and let the sample cool to room temperature before removing it from the furnace. The bead sample should now be melted into a fused, opaque mass of uniform color. Be aware that the evaporating dish will often crack upon cooling. Use a BYK-Gardner "Color Guide" spectrophotometer to measure the color of the fused beads in CIE L*a*b* color mode. Measure the color of the top surface of the fused bead sample without removing the glass beads from the porcelain dish. The spectrophotometer should be calibrated using 2-degree Observer and D65 Illuminant conditions and 45/0-degree geometry. Make 3 color measurements and obtain an average L* value. The L* value of the fused bead sample should be greater than or equal to 55.

3.2 Type II (Moisture Proof): Type II beads shall conform to all the requirements for Type

I and Type II beads above, and the following requirement for moisture resistance.

3.2.1 Moisture Resistance Test (Flow): Moisture resistance of the beads shall be determined by the following procedure.

1. Use a pre-washed 267 mm x 444 mm unbleached cotton sheeting bag having a 48 x 48-thread count.
2. Turn the bag inside out to prevent water and beads from being entrapped within the seams.
3. Place a 907 g sample of beads into the cotton bag.
4. Immerse the bag containing the sample in a bucket of water at room temperature (21-22°C) for 30 seconds, or until the water covers the beads (whichever is longer).
5. Remove the bag and sample from water and squeeze the excess water out of the bag by twisting the neck of the bag.
6. Using a rope and a ring stand, suspended the bag of beads above the table for 2 hours at room temperature. Do not allow the neck to loosen.
7. Mix the sample thoroughly by releasing the tension in the neck and shaking the bag, thus loosening the beads from bottom and sides.
8. Transfer the entire sample from the bag into a clean, dry, glass funnel (with funnel dimensions: 150 mm top diameter, 120 mm deep cone, 150 mm long stem with 6.35 mm I.D.).
9. If the beads bridge in the funnel while pouring the sample in, the funnel can be tapped lightly at the beginning to restart the flow, but not again once the flow has restarted.
10. After flow stops, the funnel must be essentially empty of glass spheres. If not, then the sample fails.

4.0 QUALITY ASSURANCE PROVISIONS

4.1 Inspection and Sampling: All lots of glass beads intended for shipment to California Department of Transportation (Department) Maintenance facilities must be sampled, tested and approved by the Transportation Laboratory before shipment. Manufacturers shall take duplicate, representative 1-quart samples of each lot of glass beads destined for the Department and send these samples to the Transportation Laboratory for testing. The duplicate samples shall be packaged in separate 1-quart wide-mouth metal paint cans.

The can lids shall be secured with clips to prevent spillage during shipment. The sample cans shall be labeled with the specification number, lot number, purchase order number (if known) and size of the lot (in kg) represented by the samples. The samples shall be shipped to the Transportation Laboratory at the address shown below.

California Department of Transportation
Transportation Laboratory, Chemical Testing Section
5900 Folsom Blvd.
Sacramento, CA 95819-0128
attn.: Lisa Dobeck

A lot shall consist of a uniform blend of glass beads packaged on the same day. The lot size shall be more than 1000 kg and shall be less than 32000 kg of glass beads. Different lot numbers shall be used when more than 32000 kg of the same blend of glass beads are packaged on the same day. Each package (bulk, barrels or bags) shall be labeled with the specification number, manufacturer's lot number and date of manufacture (packaging date). See section 5.2 "Markings" for more labeling requirements.

Manufacturers must submit the following information along with the duplicate representative 1-quart samples of each lot sent to the Transportation Laboratory for testing;

1. State Specification number (#8010-004, dated January 2004).
2. Glass bead type: Type I (uncoated) or Type II (moisture-proof).
3. Lot number
4. Date of manufacture.
5. Amount of glass beads represented by lot.
6. Purchase Order and/or Contract number (if known)
7. Type of packaging (bulk, barrels or bags).
8. Sampling method (splitting, thieving, quartering, random bag, etc.).
9. Manufacturers lab results for the following tests (Gradation, Moisture Resistance Test, Appearance) when tested per Specification #8010-004.

The samples and above information shall be sent to the Transportation Laboratory at the address listed above.

4.2 Testing: The material shall be tested per the requirements of this specification and the Invitation for Bid. The Department of Transportation reserves the right to retest any lot of glass beads after delivery. Data from such retesting shall prevail over all other tests and will be the basis of rejection. Material not meeting the specification shall be removed and replaced by the supplier at their expense, including all costs for handling, retesting and shipping.

4.3 Notification of Shipments:
Once the Transportation Laboratory approves a lot of glass beads, the manufacturer will be notified that the lot is approved for shipment. When shipments of the approved lots of

glass beads are made to Department Maintenance facilities, the manufacturer shall fax the following information to the Transportation Laboratory within 48 hours of shipment.

- * State Specification number (#8010-004, dated Jan. 2004).
- * A list of each delivery location and delivery date.
- * Name and phone number of contact person(s) at the delivery location(s).
- * Purchase Order number, contract number and date that order was received.
- * Lot numbers and quantities of each lot of glass beads delivered.

This information shall be faxed to;

California Department of Transportation
Transportation Laboratory, Chemical Testing Section
5900 Folsom Blvd.
Sacramento, CA 95819-0128
attn.: Lisa Dobeck,
Fax: (916) 227-7168.

4.4 Certificate of Compliance:

A Certificate of Compliance signed by the manufacturer shall accompany the samples. The Certificate of Compliance shall state that the lot of glass beads meets the required specification and shall contain the information listed in items 1 through 6 in the "Inspection and Sampling" section above.

5.0 PREPARATION FOR DELIVERY

5.1 Packaging:

- (1) Bags: Glass spheres shall be packaged in pinch bottom style paper bags having glued top and bottom seams. Bags shall comply with the requirements of Federal Specification UU-S-48, Type VI, Style B, MB-3, Sack 13.

Each bag shall contain 23 kg (50 lb) of glass spheres and shall be plainly and conspicuously marked or branded on the side with the net weight of the glass spheres.

- (2) Fiber Drums: Drums shall conform to the Uniform National Freight Classification, Item 21840, Rule No. 291. These shall be designed for 249 kg (550 lb) of beads and have a 508 mm inside diameter and 825.5 mm inside height. The drums must pass a 454 kg sidewall test. The top cover shall be of steel with locking rim. A polyethylene liner shall be placed in the drum before filling. Four drums shall be placed on a 1.1 m x 1.1 m pallet. Shrink-wrap shall be placed around the four drums.
- (3) Totes: Shall meet the requirements of Agency Specification #8010-005.

Packaging shall conform to the applicable rules and sections of the current National Motor Freight Classification in use at the time of delivery. Deviation from packaging requirements shall require written consent of Department of Transportation, Office of Procurement and Contracts.

5.2 Markings: All packages shall be labeled with the following information; manufacturer's name and address, State specification number (#8010-004, dated Jan. 2004), lot number and date of manufacture. Type I beads shall be marked with a wide blue diagonal stripe on the outside of the bag.

5.3 Shipping: See the Invitation for Bid.

5.3.1 Pallets: Bags shall be palletized on pallets furnished by the vendor. The pallets shall become the property of the State of California. The pallets shall meet all the requirements of State Specification 3990-XXX-01, Type II, Size 2. The size shall be 1.1 m by 1.1 m. The outside of one stringer shall be stenciled, "Return to Department of Transportation Warehouse".

5.3.2 Palletizing: 48 bags per pallet. The loaded pallets shall be plastic shrink-wrapped.

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